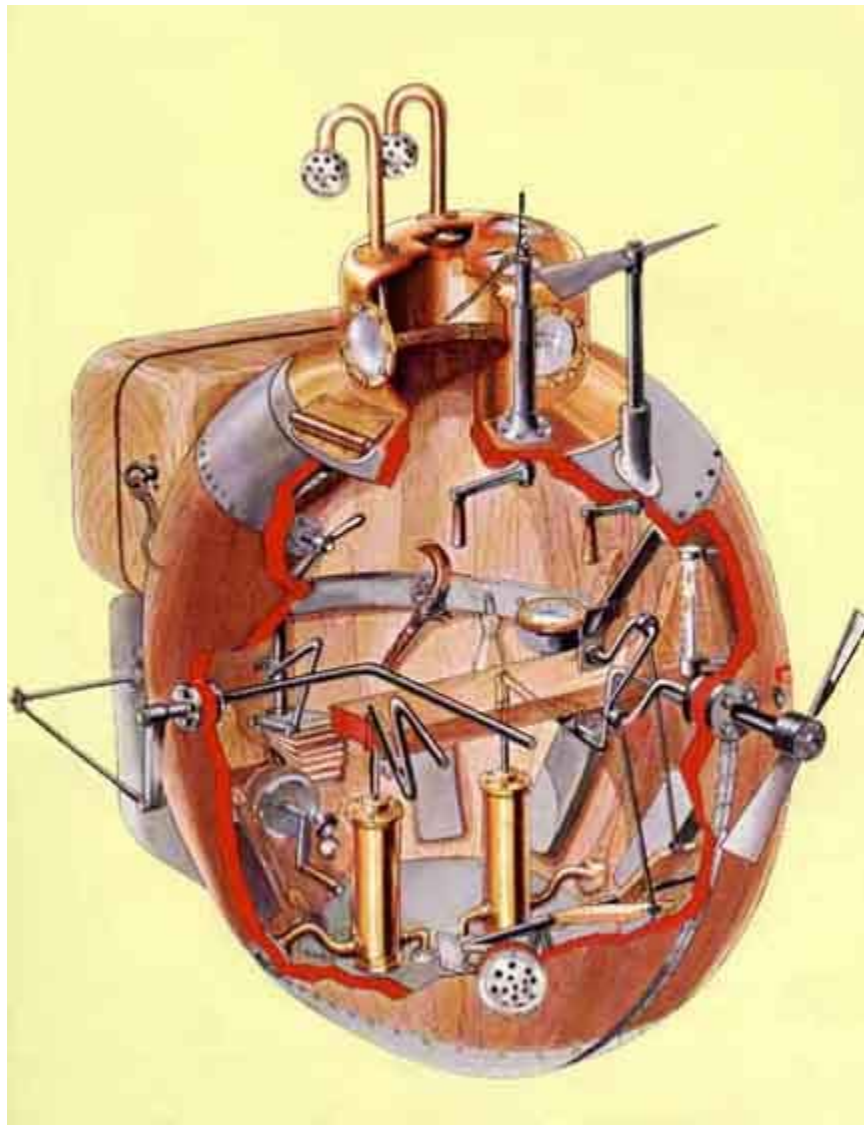




The Re-Invention of Bushnell's Turtle



A Brief History of TURTLE¹

In 1776, the British controlled New York harbor with its fleet thus, controlling the Hudson River Valley, which effectively split the colonies in two. The Americans lacked a navy but they needed to find a way to end this naval blockade. David Bushnell of Saybrook, Connecticut, a recent graduate of Yale and ardent patriot, designed and built the *Turtle* for this purpose.

Made out of wood and held together by iron hoops, the *Turtle* was six feet in height and just over seven feet in length and had enough room for a single operator. At the bottom of the submarine, there was an opening, which allowed water into the ballast tanks, enabling it to submerge and to surface. The pilot used two brass pumps to empty the tanks. The submarine could remain submerged for 30 minutes before running out of air. The submarine's only weapon was a mine, attached near the top of the submarine. The mine was another invention of Bushnell's. It was a watertight wooden keg filled with packed gunpowder, a fuse and a clock-timer device.

The goal of the *Turtle's* mission was to break this blockade by attacking the British fleet in New York harbor. The target was Admiral Richard Howe's flagship, the *HMS Eagle*. Ezra Bushnell, the inventor's brother, was supposed to carry out the task but on the eve of this mission, he became ill and someone else had to take his place. That someone was Sergeant Ezra Lee of Old Lyme, Connecticut. David Bushnell quickly taught him how to maneuver the submarine and how to deploy the mine. After a few practice sessions, Lee was ready.

The *Turtle* set out on its historic mission shortly after midnight, September 7, 1776. It managed to reach the *Eagle*, submerge and slip beneath the ship's keel undetected. Sergeant Lee made two attempts to attach the mine to the bottom of the ship, but failed because he could not penetrate the copper sheathed hull. Failing to attach the mine, he had no choice but to abandon his mission and return.

In his return from the ship to New York, he passed near Governor's Island, and thought he was discovered by the enemy on the island. Being in haste to avoid the danger he feared, he cast off the magazine, as he imagined it retarded him in the swell, which was very considerable. After the magazine had been cast off one hour, the time the internal apparatus was set to run, it blew up with great violence, throwing a vast column of water to an amazing height in the air, and leaving the enemy to conjecture whether the stupendous noise was produced by a bomb, a meteor, a water-spout, or an earthquake.

Despite the failure to sink the ship, the submarine performed as designed by forcing the British to move their fleet to a safer position. It was the first attempt to end a naval blockade by using a submarine. Even though the attempt failed, military planners took notice that the submarine had potential as a weapon.

¹ Excerpt taken from <http://patriot.history1700s.com/article18.shtml>

Plans For The Recreation of TURTLE

The Discovery Channel, in cooperation with Channel 4 in the UK is co-producing a one-hour documentary film to reconstruct and recreate the *Turtle* and its historic undersea warfare mission during the American Revolution. The film, one in a series entitled "Inventing the Past" is programmed to be broadcast in the U. S., Great Britain, France and Canada in late 2003. Other programs in the series include: Chariots, Medieval Crane, and Greek Fire. Michael Barnes is the director of the project and is currently associated with Windfall Films in London. The Discovery Channel and Windfall Films have done a number of these experimental archaeology films as part of this popular series.

Midshipmen and faculty of the U.S. Naval Academy have been invited to be a part of this reconstruction by participating as the primary engineering design and testing component of the *Turtle* team. It is only fitting that our future undersea warfare officers be actively involved in recreating the first submersible ever involved in undersea warfare. Design efforts at the Naval Academy are presently underway in a number of engineering classes (see details below) and are expected to continue in the Spring semester prior to the *Turtle's* open water sea debut and mission recreation -- possibly in a harbor around the Boston area in June 2003. Broadcast of the one-hour program will vary, but most likely be in summer/fall of 2003 for most broadcasters.

Midshipmen designs for the *Turtle* will be fabricated in Boston during late Fall/early Spring by a team of craftsmen and carpenters from the Massachusetts College of Art using authentic methods and techniques. It will then be assembled in Boston where initial tank testing will be conducted prior to final tow tank testing by midshipmen at the Naval Academy near the end of Spring semester 2003. This effort will involve more comprehensive testing by midshipmen to analyze the engineering aspects of the *Turtle*. All testing by the midshipmen at the Naval Academy will be unmanned testing.

Midshipmen Involvement

As a part of the reconstruction of the *Turtle*, midshipmen at the US Naval Academy have already started to become involved and are planned to continue this involvement throughout the 2003 academic year. Three courses taught in the Department of Naval Architecture and Ocean Engineering are presently employing students in various aspects of the initial design of the *Turtle*. Specifically

- Principles of Ocean Engineering (EN245): Third class ocean engineers are using a set of *Turtle* hull dimensions to calculate the submersible's hydrostatic properties to include displacement.
- Ocean Thermal Systems (EN425): First class midshipmen are making preliminary calculations to design some of the *Turtle's* support systems and estimate the habitability of the submersible. Their projects include designing the ballast

pumps, performing a psychrometric analysis, estimating oxygen depletion and carbon dioxide build-up, and determining the heat transfer characteristics of the vessel.

- Underwater Work Systems (EN430): A team of first class ocean and systems engineers is developing an initial design of the submersible based on historical documentation. This initial design will be used as their semester design project and will be used to furnish the Massachusetts College of Art with needed information so that they can begin construction of the submersible.

The foundations are also being laid for a number of first class midshipmen to use the *Turtle* as a part of their capstone design courses and independent research projects for the Spring semester.

- Ocean Engineering II (EN462): A team will be taking the preliminary calculations from EN425 and the initial design from the EN430 project to develop a more detailed design of the internals of the *Turtle*. This project will serve as the capstone design project for this team of ocean engineers.
- Additionally, there will be a first class History major involved in conducting an archival search and detailing an historical account of the *Turtle* and its inventor, David Bushnell. This account will be done as a part of the midshipman's independent research project.
- Finally there will be two independent research students from the Department of Naval Architecture and Ocean Engineering using this opportunity for completing an independent research project. A naval architect will be designing and testing the propulsion systems of the *Turtle* based on the historical documentation. An ocean engineer will be developing a scale model of the vessel for resistance and propulsion tests and, if feasible, will be able to complete unmanned testing of the actual reconstructed *Turtle* when it is delivered to the academy in the Spring.

The opportunity that the Discovery Channel has presented to us by being involved in this reconstruction project has exceptional academic benefits. The midshipmen that are currently involved in the project are extremely excited about being able to apply their knowledge of basic engineering principles to a real-world project. Additionally, this reconstruction allows the midshipmen the opportunity to work on a project that has direct historical significance to their careers as naval officers, namely one of the first documented cases of the United States military attacking an enemy vessel using a submersible. This project will undoubtedly have immeasurable recruiting value for the Naval Academy, and particularly, the Division of Engineering and Weapons. Finally, because of the vast audience that the Discovery Channel reaches, this project will provide an invaluable opportunity for the Naval Academy to showcase its academic programs.